

therefore, also be regarded as primitive, though separated from Decolopoda by many differences. The Pallenidæ are closely allied to the Nymphonidæ. The Phoxichilidiidæ have points of resemblance with the Pallenidæ, and the Pycnogonidæ are probably allied to them. The ideas here expressed as to the relations of the different families have, however, recently been questioned by Carpenter, whose views have received support from Calman. According to these authors, the fifth pair of legs in Decolopoda and in Penta-nymphon may possibly represent a comparatively new development and not a primitive character.

MORTALITY TABLES.

The Theory of the Construction of Tables of Mortality and of Similar Statistical Tables in Use by the Actuary. A course of lectures delivered at the Institute of Actuaries, Staple Inn Hall, during the Session 1904-5, by G. F. Hardy. Pp. iii+141. (London: C. and E. Layton, 1909.) Price 7s. 6d.

THIS course of lectures, which was delivered under the auspices of the Institute of Actuaries, deals with the construction of mortality and similar tables which, as the author justly observes in his opening sentence, lie at the very basis of actuarial work. They deal succinctly with familiar methods of graduation, such as the graphic and Woolhouse's difference method, but are for the most part devoted to more modern theories of curve-fitting, and to the application of Makeham's hypothesis in dealing with the somewhat intractable curve which arises from the fact that, with assured lives, the rate of mortality is for several years a function of time that has elapsed since medical examination rather than of age.

It may be remarked that a subject involving much technical mathematical detail cannot be satisfactorily dealt with in the form of lectures. Mr. Hardy's first two lectures deal with methods of graduation which are familiar to most actuaries, and can be suitably presented in this form, but the remaining four lectures contain much original work, which can only be thoroughly understood after careful reading and study. Fortunately, Mr. Hardy appears to have realised the limitations of his medium, and in its present form the work is well suited to the actuarial student.

The publication of this book is of special interest, as a perusal of it shows that modern development in the graduation of tables of mortality has, singularly enough, had its impulse and inspiration from outside the actuarial profession. To Prof. Karl Pearson's original work in the field of biological statistics, actuaries are indebted for the new calculus, which was applied by Mr. Hardy in the graduation of the principal mortality tables compiled from the experience of lives assured in British offices, and published a few years ago. Actuaries, indeed, cannot be said to have taken very readily to the new method, and during the last three years there has been a surprising number of contributions in the *Journal of the Institute of Actuaries* dealing with the development of those finite difference formulas to which Mr. Hardy

devotes only half-a-dozen pages in this book, and which will, we hope, in a few years be considered obsolete.

The most interesting part of the book is that dealing with the Pearsonian frequency curves, and it is suggestive of the exhaustive nature of the work done by Prof. Pearson to find that so original a thinker as Mr. Hardy has practically nothing to add to the information we have already received about this important family of curves. He, in fact, refers the reader to Prof. Pearson's works, and to the treatise of Mr. W. Palin Elderton, for fuller information. The latter work was published only three years ago for the benefit of actuaries, and will, we think, hold the field as the only text-book on the subject for some years. In these circumstances, it may perhaps be regretted that Mr. Hardy has seen fit to re-number the types of curves, as this may easily confuse anyone who finds occasion for reference to both books, or to Pearson's original work, which Elderton follows. The student will also be in difficulty at the outset owing to Mr. Hardy giving the differential equation from which these curves are derived as

$$\frac{1}{y} \cdot \frac{dy}{dx} = \frac{bx - x^2}{a - bx - cx^2},$$

instead of the one to which we are accustomed,

$$\frac{1}{y} \cdot \frac{dy}{dx} = \frac{x+a}{b_0 + b_1x + b_2x^2 + \dots},$$

and we may mention that a misprint would appear to have been introduced here, as it does not seem possible to derive Pearson's Type I. from the first-mentioned equation.

It is unfortunate that Mr. Hardy has not illustrated this part of his subject by reference to the chief mortality table, in the graduation of which the method of frequency curves has been employed, and was carried out by himself. When it is remembered that this will now be the standard mortality table for many life-insurance purposes, it seems strange that so favourable an opportunity should have been missed.

In justice, however, to the author, it may be as well to say that, taking into consideration the space at his disposal, he has done wisely in devoting so large a proportion of it to the study of the Makeham curves, in the knowledge and manipulation of which he is so able an exponent. At the second International Congress of Actuaries, one of the most eminent of Continental actuaries stated that, in his opinion, the day had entirely gone past in which Makeham's graduation would be practically applied in the graduation of tables; and it is a singular commentary on this statement that the select annuity and assurance tables of the recent experience have been graduated by the application of the formula in question. In order to prove the importance of this matter to actuaries, it is only necessary to point out that the value of an annuity payable during the joint life of two persons of any age can be found from a table giving the annuity values for two lives of equal age, whereas, in the case of a table graduated on different principles, a large volume would be required.

Mr. Hardy's illustrations of the application of

Makeham's curve to the general population will be of great interest to all statisticians.

The publication of these lectures marks, we hope, a turning-point in actuarial graduation; it means that the study of curve-fitting has now become a part of the curriculum of the actuarial student, and a knowledge of frequency curves must be acquired before the diploma of the Institute is won. This recent development has enormously increased our power of interpreting statistics, and Mr. Hardy will have done actuarial science a great service if this book induces the other members of his profession to follow in his footsteps.

MODERN ORDNANCE.

The Engineering of Ordnance. By Sir A. Trevor Dawson. The Gustave Canet Lecture, delivered at the Twenty-fifth Anniversary Meeting of the Establishment of the Junior Institution of Engineers, at the Hall of the Worshipful Company of Fishmongers, June 30, 1909. Pp. iv+53. (London: Percival Marshall and Co., 1909.) Price 2s. 6d.

IT is generally understood that progress made in the construction of guns, gun-mountings, explosives, and projectiles during the last half-century far exceeds that made in the preceding five hundred years; but the causes of this great advance, and the methods by which it has been accomplished, are not so well known. In this small book, of little more than fifty pages, the author has summarised the facts in a clear and interesting style, in a fashion perfectly intelligible to ordinary readers. The descriptions of ordnance are assisted by means of a series of excellent illustrations representing ancient weapons as well as the most recent types.

The author is an eminent authority on the subjects of which he treats, and he is a master in the art of exposition. As director in charge of the Ordnance Department of Vickers, Maxim and Co., Sir Trevor Dawson has been able to utilise the valuable training and experience he had previously gained in the Royal Navy, and to play a prominent part in recent advances. The value of the work done by him has just been recognised by a knighthood, and many professional friends will join in congratulating him upon this well-deserved honour. The Junior Institution of Engineers was fortunate in obtaining the services of such a man as their first lecturer and gold medallist under the Canet bequest.

M. Gustave Canet was a most distinguished French ordnance engineer who received his principal training in this country under the late Mr. Joseph Vavasaur, and subsequently did much to advance the design and construction of ordnance in his native country in association with the great firm of Schneider and Co., of Creusot. M. Canet was president of the Institution of Junior Engineers in 1907-8; his death occurred at the close of his term of office, and his family founded a Canet Gold Medal as a memorial in accordance with a wish he had expressed. No fitter tribute to his professional eminence could have been paid than that which the volume under review contains—a tribute from a British ordnance engineer of the first rank to

the work which his French collaborateur had done in improving ordnance for both sea and land purposes.

The author has compressed and condensed a considerable mass of material into the modest limits mentioned above, at the same time indicating the great range and variety of the subjects affecting the design of modern ordnance. He has also maintained his sense of proportionate value in dealing with each item. He shows how important have been contributions made by metallurgists, chemists, and mechanical engineers, and how essential has been the work of each. Improvements in steel manufacture lie at the root of advance in gun-construction and the making of projectiles. The chemist has played a great part in these improvements, and has devised much more powerful "propellants" to take the place of gunpowder, as well as high explosives which can be safely fired from guns and be capable of working havoc on an enemy's forces or ships. The mechanical engineer has been no less useful; indeed, it is his lot to utilise all that metallurgists and chemists can do so as to embody their latest discoveries in designs for more powerful and accurate artillery, or in the construction of more efficient gun-mountings. Hydraulic, electric, and pneumatic methods of transmitting and utilising power in connection with ordnance all find a place and use, their relative value and efficiency being differently assessed by different authorities.

Sir Trevor Dawson states the case fairly, and records his own opinions in many instances. For example, what he says in regard to "wire-wound" and "solid-steel" systems of gun-construction is well worth study; and equally so are his remarks on the advantages and disadvantages of hydraulic or electrical power for working and loading heavy guns; or his comparisons of nitro-glycerine and nitro-cellulose powders. All these questions must be studied in the original volume, as limits of space prevent even a summary being given of the author's conclusions. Every reader of the book will gain a clear idea, not merely of the ingenious devices now in ordinary use for loading and working heavy guns or quick-firing guns of moderate size and weight, but of the means by which present practice has been attained. Behind the complete control and apparently easy handling of the largest guns there lies a mass of complicated machinery for the proper maintenance and use of which highly trained staffs are necessary. The "sweet simplicity" which prevailed before steam-power and armour-defence came into use has entirely disappeared, and cannot be restored. One comparison may be mentioned in conclusion. In 1864 the most powerful 12-inch gun was a muzzle loader, twelve calibres in length, weighing about 23½ tons; its charge of powder weighed 85 lb., the muzzle velocity of the 614 lb. projectile was 1300 feet per second, and it could perforate 16 inches of wrought-iron armour at the muzzle, or 8 inches at the maximum range of 6000 yards. The 12-inch gun of 1909 is a breech-loader, fifty calibres long, weighing nearly 70 tons. Its projectile weighs 850 lb., the muzzle velocity is 3000 feet per second, its perforative power is measured by 52 inches of wrought iron at the muzzle, 37 inches at